

“Disaster Risk Mitigation in Palestine”
Nablus, February 26th 2013

Seismic Risk Assessment of Roadway Network in Italy

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The majority of the Italian RC bridges and road transportation networks was built more than 30 years ago and they result to be extremely vulnerable from a seismic point of view.

WHY?

- A significant amount of **bridges, tunnels, retaining walls** was built before:
 - The introduction of modern seismic code provisions.
 - 1984 when the whole Italian territory was systematically classified in terms of seismic hazard leading to the identification of the areas where it was mandatory to design according to seismic code provisions.
- Furthermore, seismic hazard classification of Italy was updated several times.



Framework: Project funded by the Italian Department of Civil Protection

Main objectives:

1. Evaluation of the seismic risk assessment of the Italian roadway network
2. Proper classification of structures according to their seismic risk
3. Optimal management of the available resources
4. Definition of intervention priorities
5. Support for decisions during earthquake warning



BRIDGES

Object of study:

Seismic risk assessment of the **existing Italian RC multi-span simply supported and continuous bridges at a national scale**



Research has been carried out in collaboration with the *University of Rome "La Sapienza"*



AVAILABLE DATABASES

ANAS Catasto



ANAS Soawe



Provincia Trento



Network owners	Bridges	Georeferentiation	Geometry	Structural data
ANAS Catasto	14966	✓	✗	✗
ANAS Soawe	446	✓	✓	✓
Provincia Trento	1008	✓	✓ / ✗	✗



AVAILABLE DATABASES

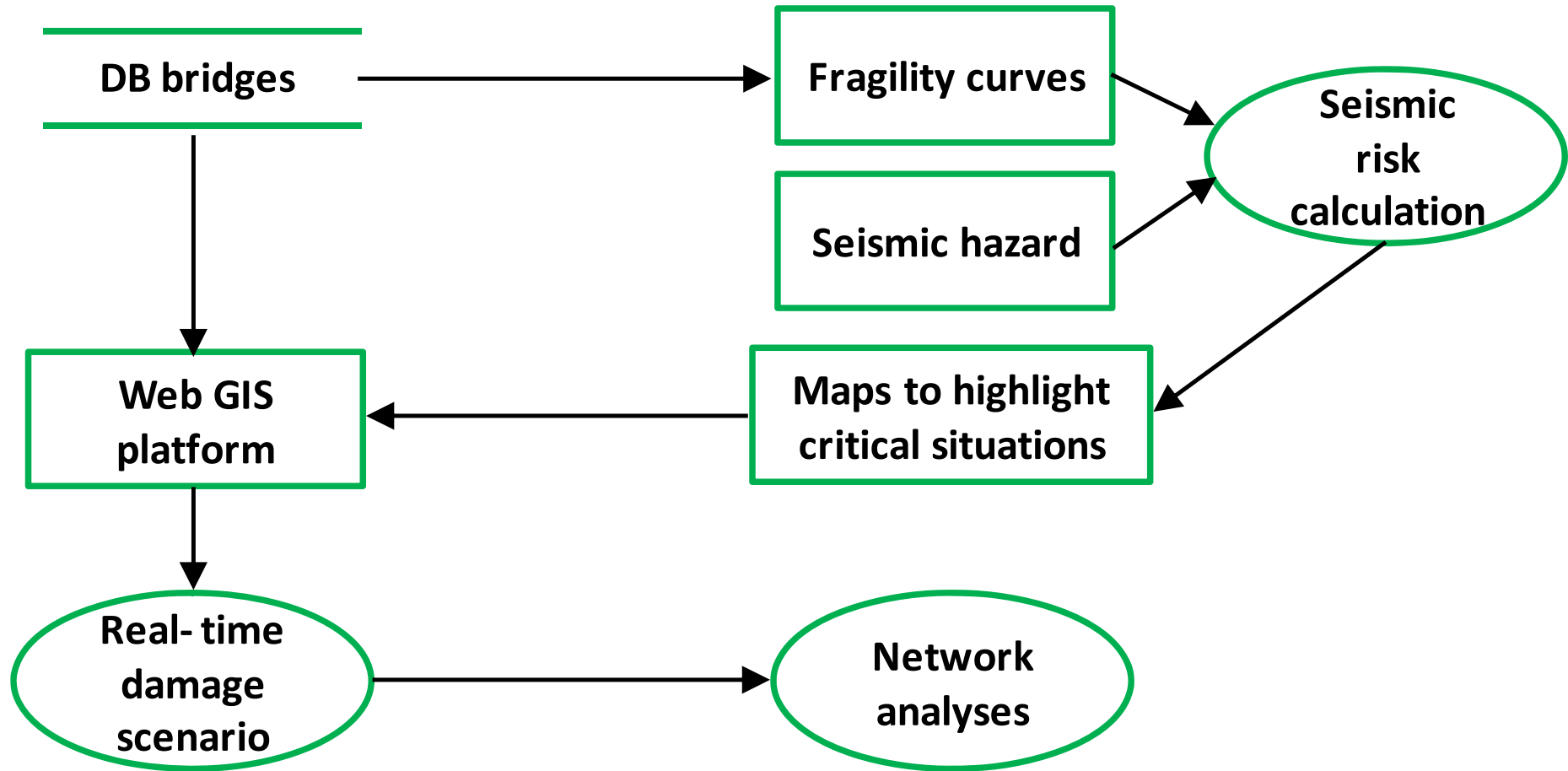
Autostrade per l'Italia



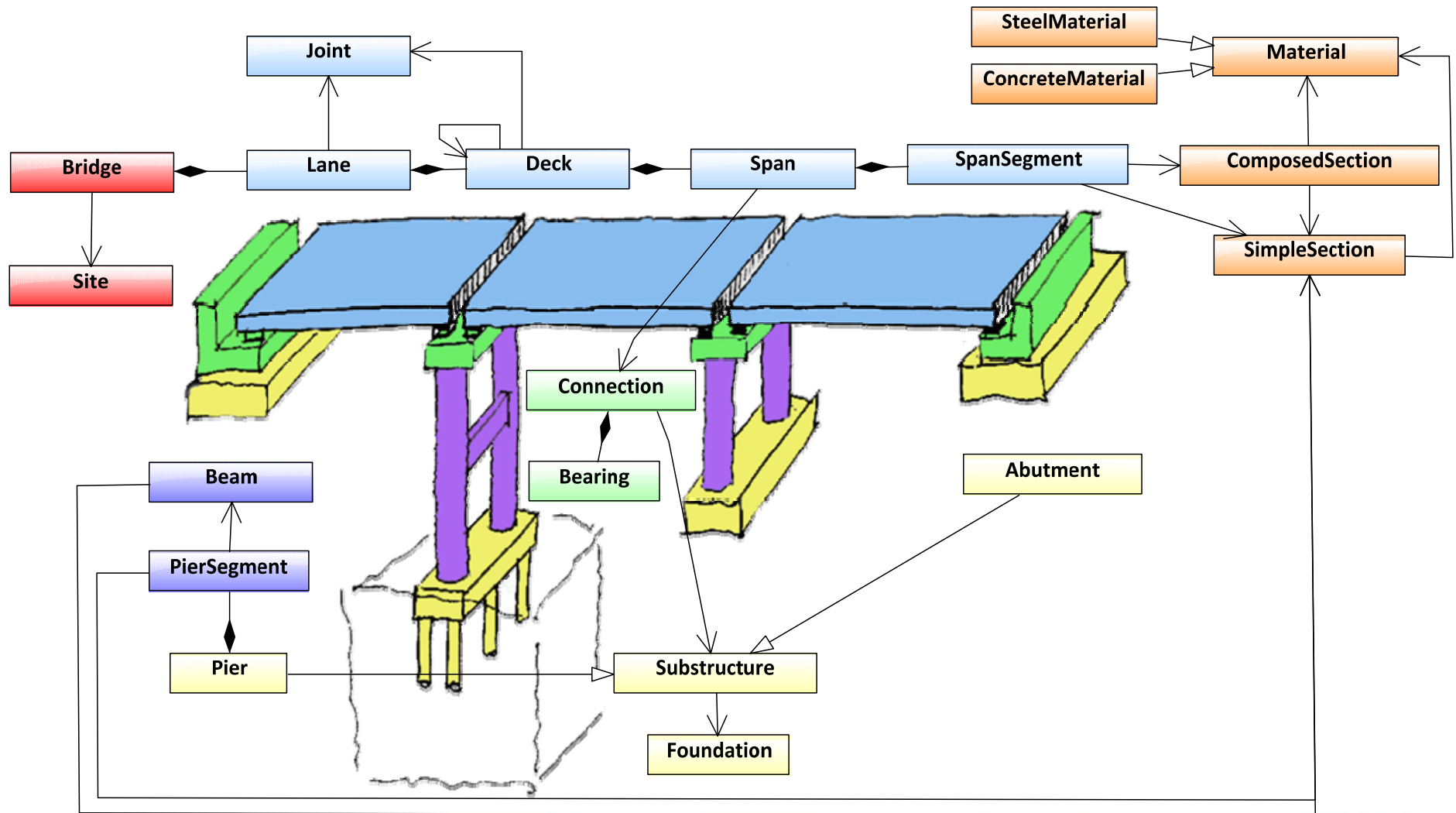
Network owners	Bridges	Georeferentiation	Geometry	Structural data
Aut. per l'Italia	1310	✓	✓ / ✗	✓ / ✗



WORKFLOW



DEVELOPED DATABASE and BRIDGE INFORMATION MODEL



SEISMIC FRAGILITY CURVES

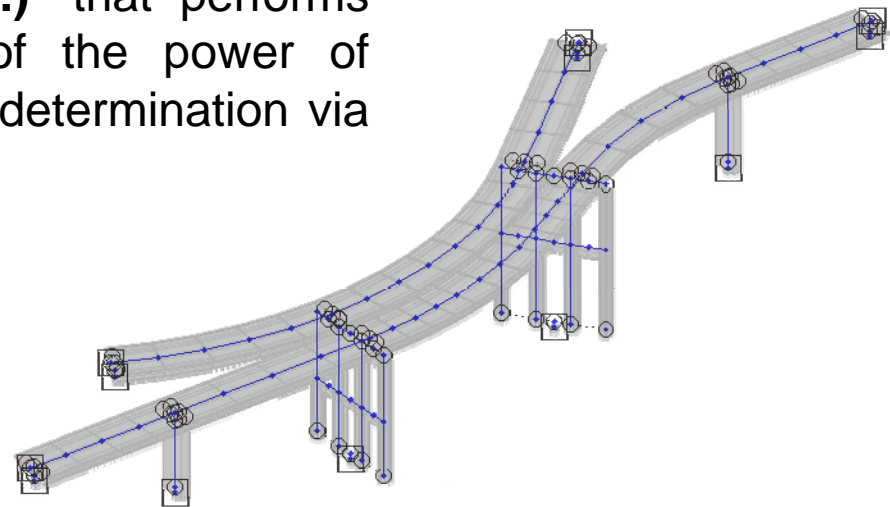
High level of detail



the **fragility curves are computed** for each bridge

Development of an application “**BRidge auTomatic Nlth-based Earthquake fragilitY (BRI.T.N.E.Y.)**” that performs fragility analysis of bridges and rests of the power of OpenSees analysis package for response determination via inelastic response history analysis

1. Ground motion simulation according to Italian seismic code
2. Simulation of bridge response to account for uncertainty in bridges properties



Damage and **collapse** limit states/performance levels

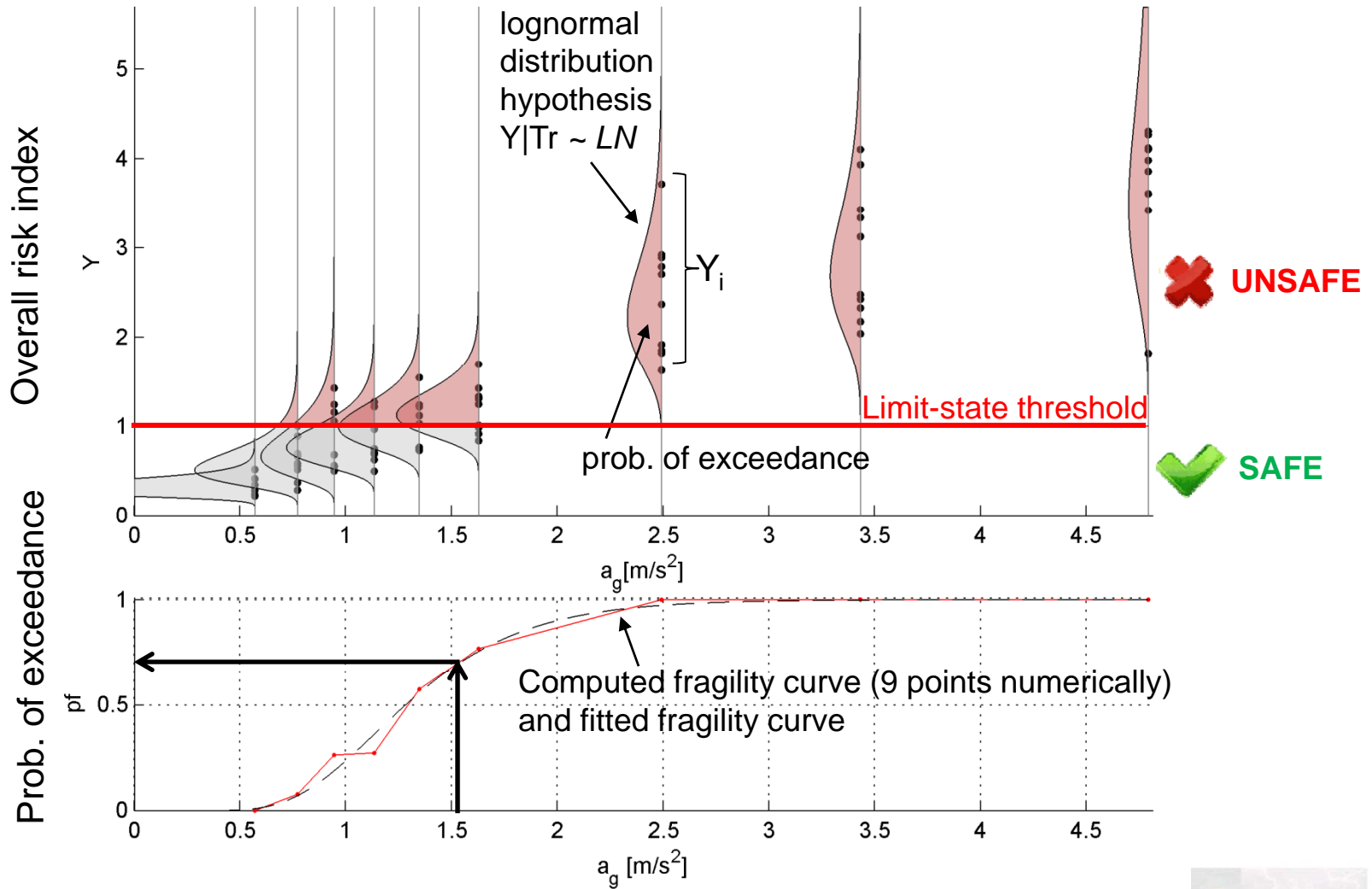


400 bridges × **90** simulations ∇ bridge (9 Return Periods and 10 Monte Carlo samples) × **2/3** modelling assumptions = **72'000 ÷ 108'000** runs



SEISMIC FRAGILITY CURVES

High level of detail



SEISMIC FRAGILITY CURVES

Low level of detail

Statistical analyses of results obtained by the calculated fragility curves to obtain the average ones

➔ “Mean” fragility curves associated, \forall limit state and \forall modelling assumption, to the bridges when only the geographical position is known

Medium level of detail

A **probabilistic model** for the fragility curves conditioned to a small set of data of the bridges is under development



Database with 18'000
reinforced concrete bridges

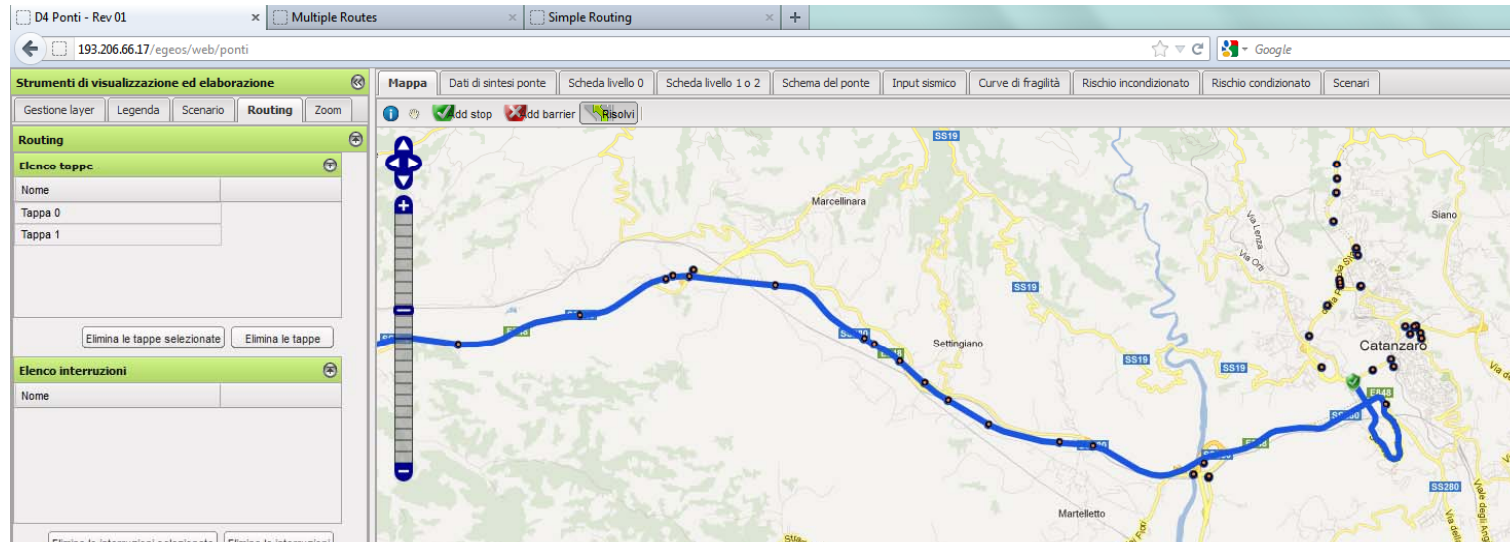
Fragility curves \forall bridge
of the database

Seismic hazard adopted
in Italian Code (INGV)

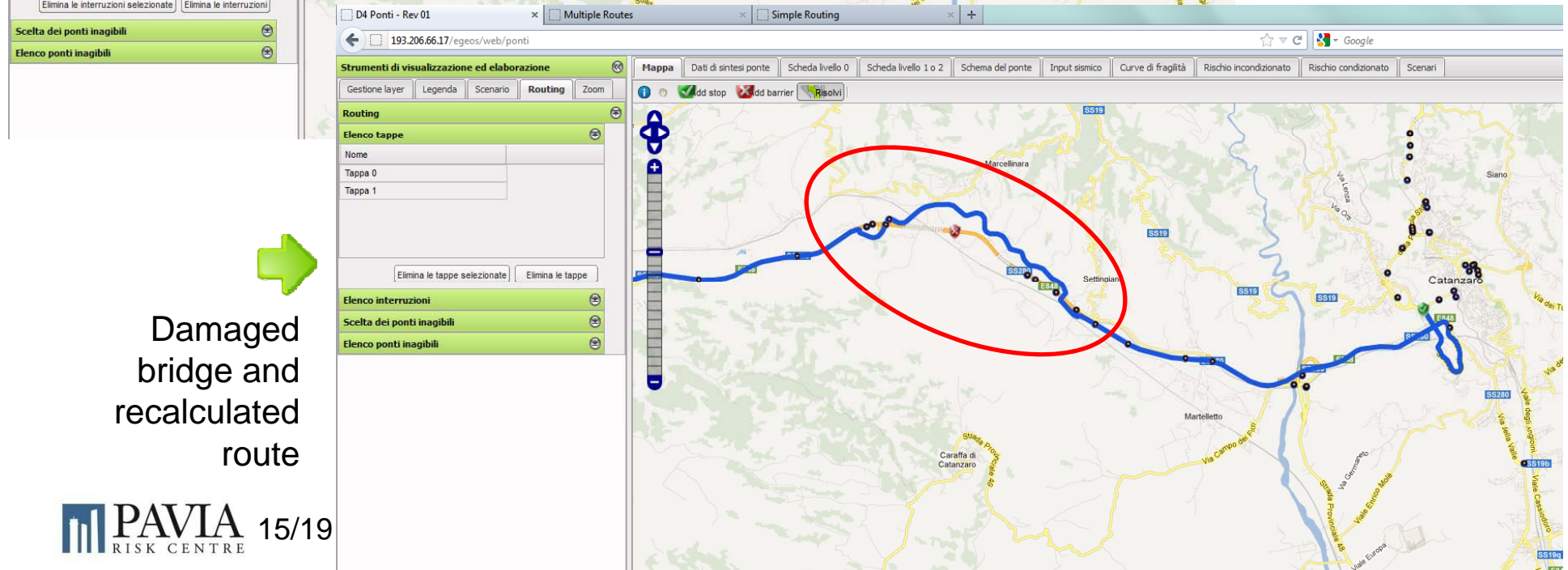
Calculation of **seismic risk**
at a national level



NETWORK ANALYSIS



without interruption



Damaged bridge and recalculated route

TUNNELS



EUCENTRE

European Centre for Training and Research in Earthquake Engineering

AVAILABLE DATABASE



Network owner	Tunnels	Soil	Typology	Location	Geometry	Structural data
ANAS Soawe	107	✘	✔	✔	✘	✔ / ✘



RETAINING WALLS

AVAILABLE DATABASE



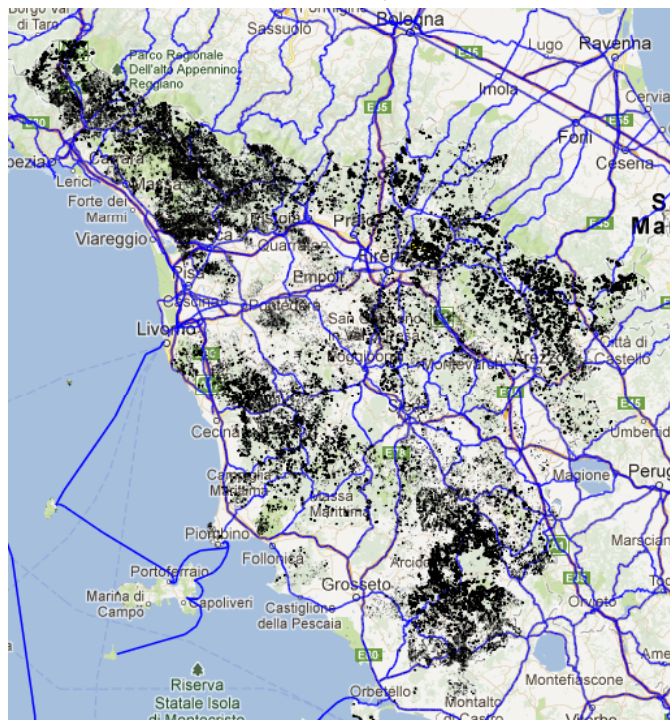
Network owner	Walls	Soil	Typology	Location	Geometry	Structural data
ANAS Soawe	7589	✘	✘	✔	✘	✘



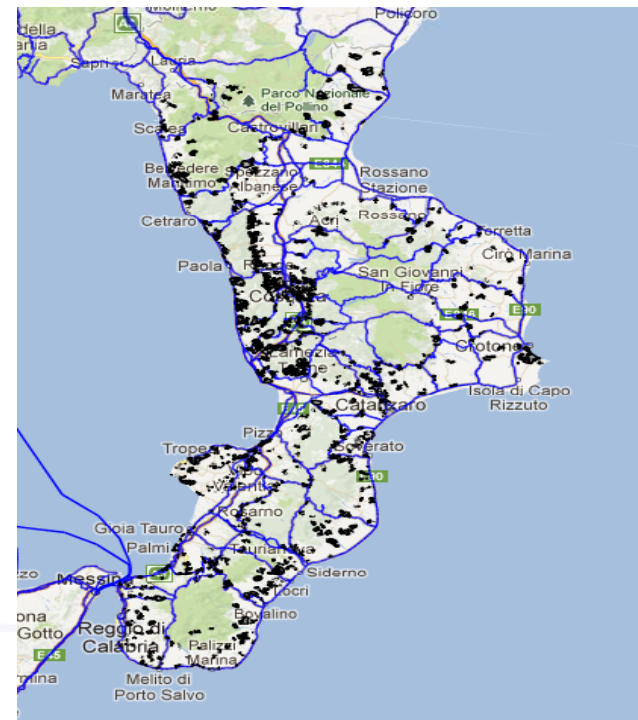
WORK IN PROGRESS

- ✓ Seismic fragility of both **tunnels** and **retaining walls**
 - No enough data for computing seismic fragility
 - Fragility curves from literature according to the level of available information
- ✓ Seismic risk of **landslips** triggered by earthquakes
 - Available database IFFI (“Inventario dei Fenomeni Franosi in Italia”). The inventory of landslips for two cases of study

Tuscany



Calabria



CLOSURE

- ✓ The evaluation of the seismic risk of the existing RC multi-span simply supported bridges was carried out at a national scale
- ✓ A WebGIS platform was developed to evaluate real-time damage scenarios and perform network analyses for bridges
- ✓ According to the available data, fragility curves were associated to the other fundamental structures of the Italian road transportation network

FUTURE DEVELOPMENTS

- Improvements of results if new data will be available
- Further development of the probabilistic model for the fragility curves conditioned to a small set of data of the bridges
- Implementation of both the fragility functions derived for tunnels and retaining walls and the study of landslips triggered by earthquakes in the WebGIS platform



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Thank you for the attention

